Tradeoffs for Renewable Energy Projects

Thomas S. Smith,
Engineer Research and Development Center, Champaign, IL

William D. Goran
Engineer Research and Development Center, Champaign, IL

Roch A. Ducey
Engineer Research and Development Center, Champaign, IL

William J. Stein
Engineer Research and Development Center, Champaign, IL

11 May 2011

US Army Corps of Engineers
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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
11 MAY 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Tradeoffs for Renewable Energy Projects	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Army Engineer Research and Development Center,Construction Engineering Research Laboratory,PO Box 9005,Champaign,IL,61826-9005**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Presented at the NDIA Environment, Energy Security & Sustainability (E2S2) Symposium & Exhibition held 9-12 May 2011 in New Orleans, LA.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**28**	

Center for the Advancement of Sustainability Innovations

Energy Policy

In accordance with the Energy Policy Act of 2005, the Energy Independence and Security Acts of 2007; and Executive Orders 13423 (*Strengthening Federal Environmental, Energy, and Transportation Management*) and 13514 (*Federal Leadership in Environment, Energy and Economic Performance*); the U.S. Government is planning to significantly improve its energy management to save taxpayer dollars, to reduce energy use and emissions that contribute to air pollution and global climate change, and to improve “energy security” for our nation.

Army's Energy Strategy and Plan
(includes five major initiatives)

- Eliminating energy waste in existing facilities
- Increasing energy efficiency in new construction and renovations
- Conserving water resources
- Improving energy security, and
- *Reducing dependence on fossil fuels through increased use of clean, renewable energy that optimizes environmental benefits and sustainability*.

ENERGY

Regardless of origin, availability and security of both renewable or non-renewable energy sources are affected by four segments of the energy chain:

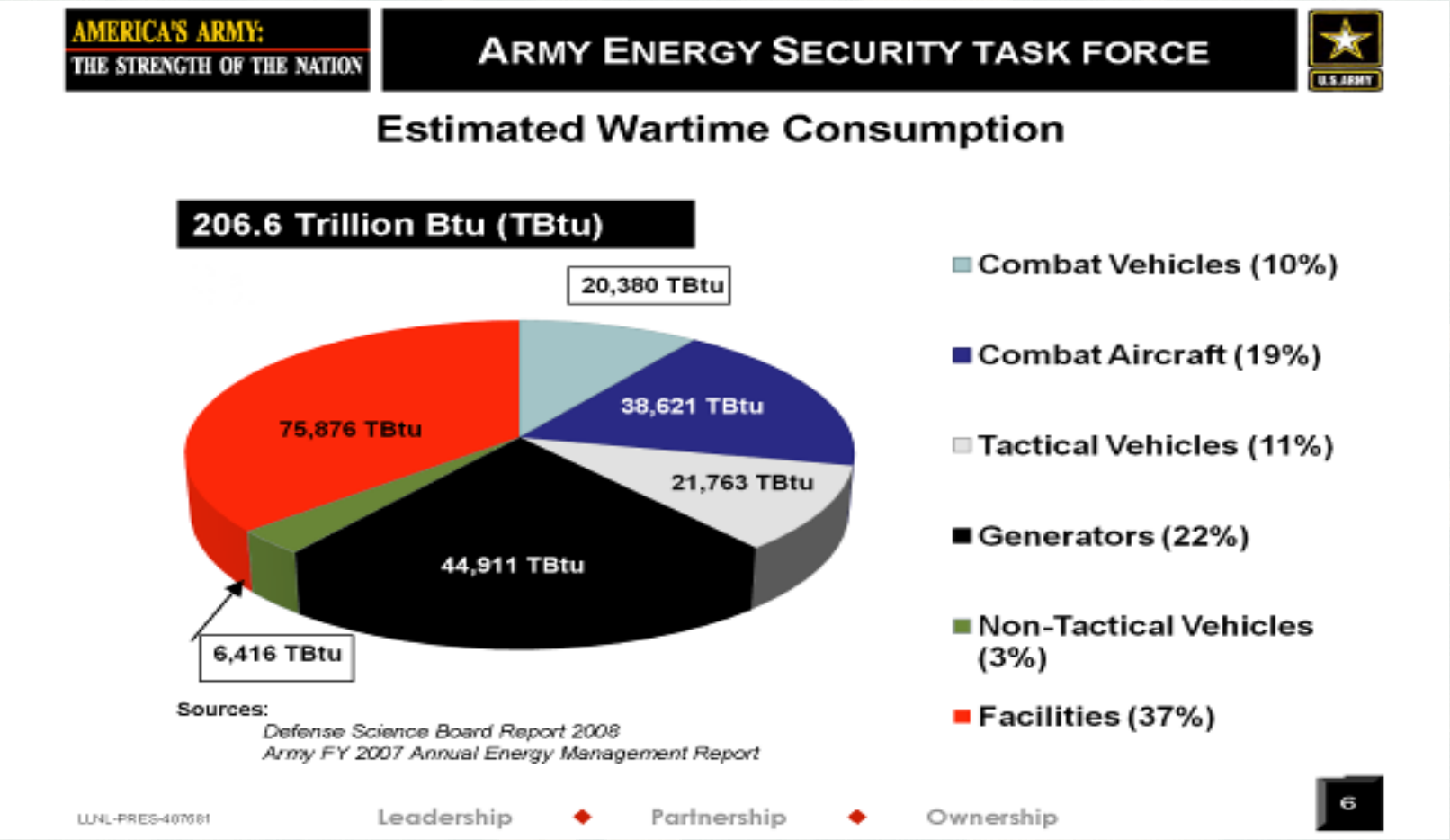
(1) resources,

(2) generation,

(3) transmission and distribution, and

(4) the end user.

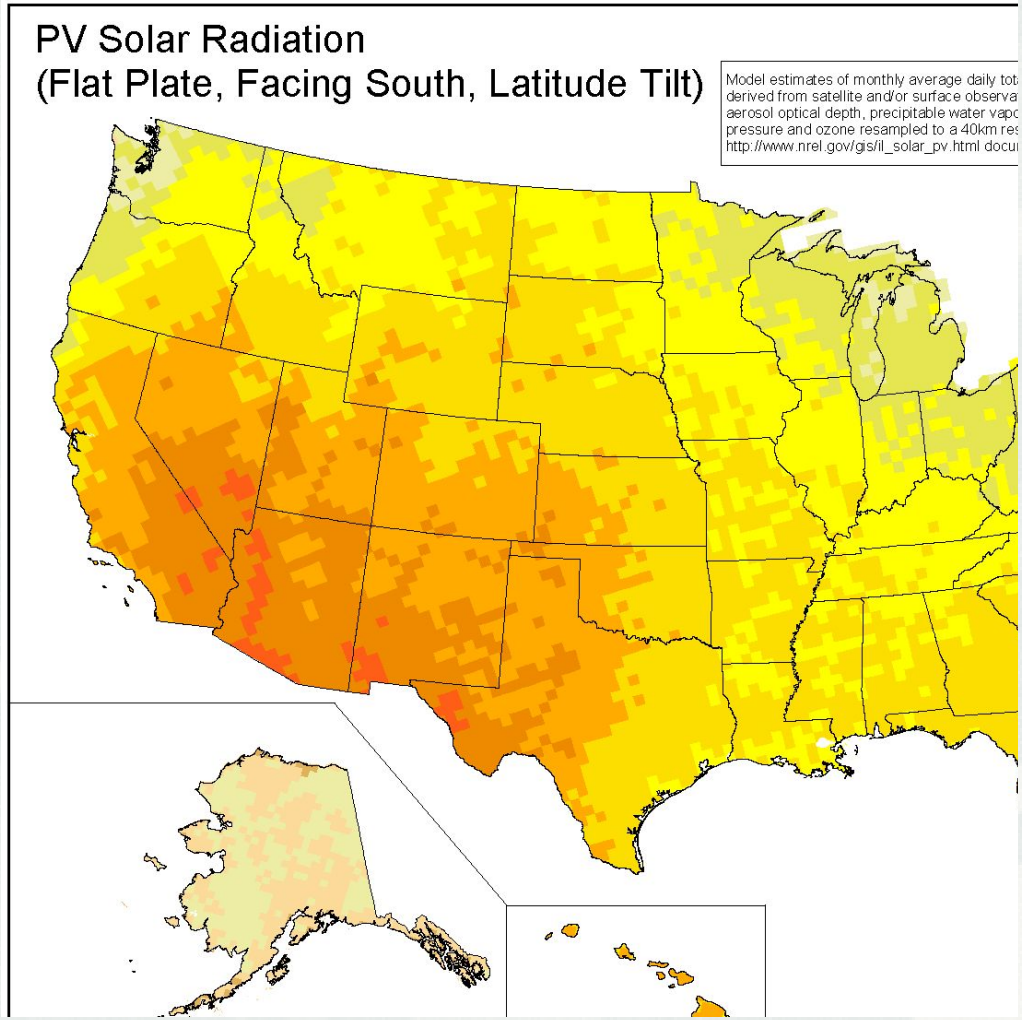
Estimated Army Energy Consumption



Renewable Energy Sources

- Solar
- Wind
- Biomass
- Geothermal

Relative Solar Radiation and Associated Solar Radiation Energy Potential



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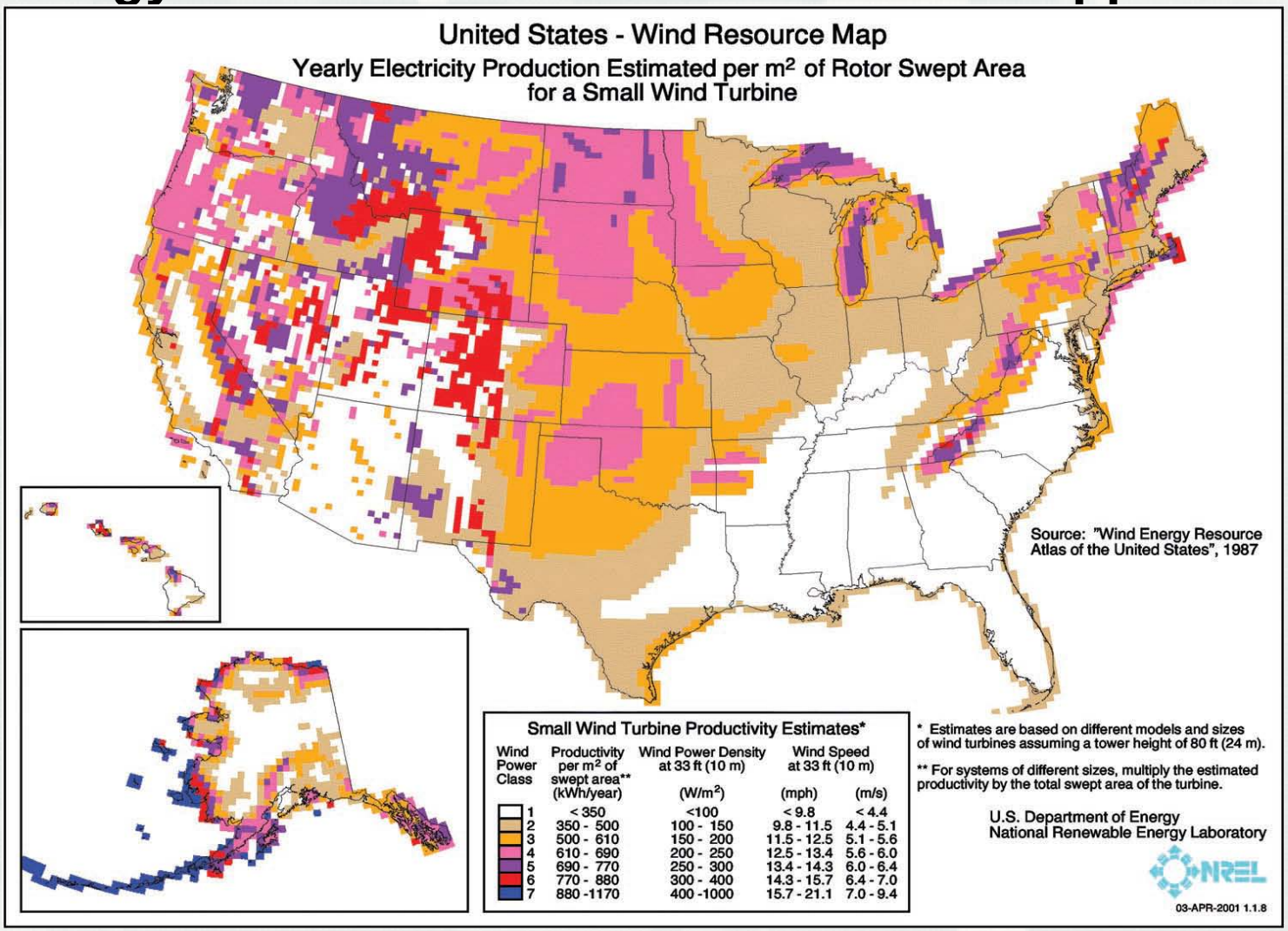
Map Of Wind Resources And Estimated Potential Electric Energy Production From Small Turbine Applications



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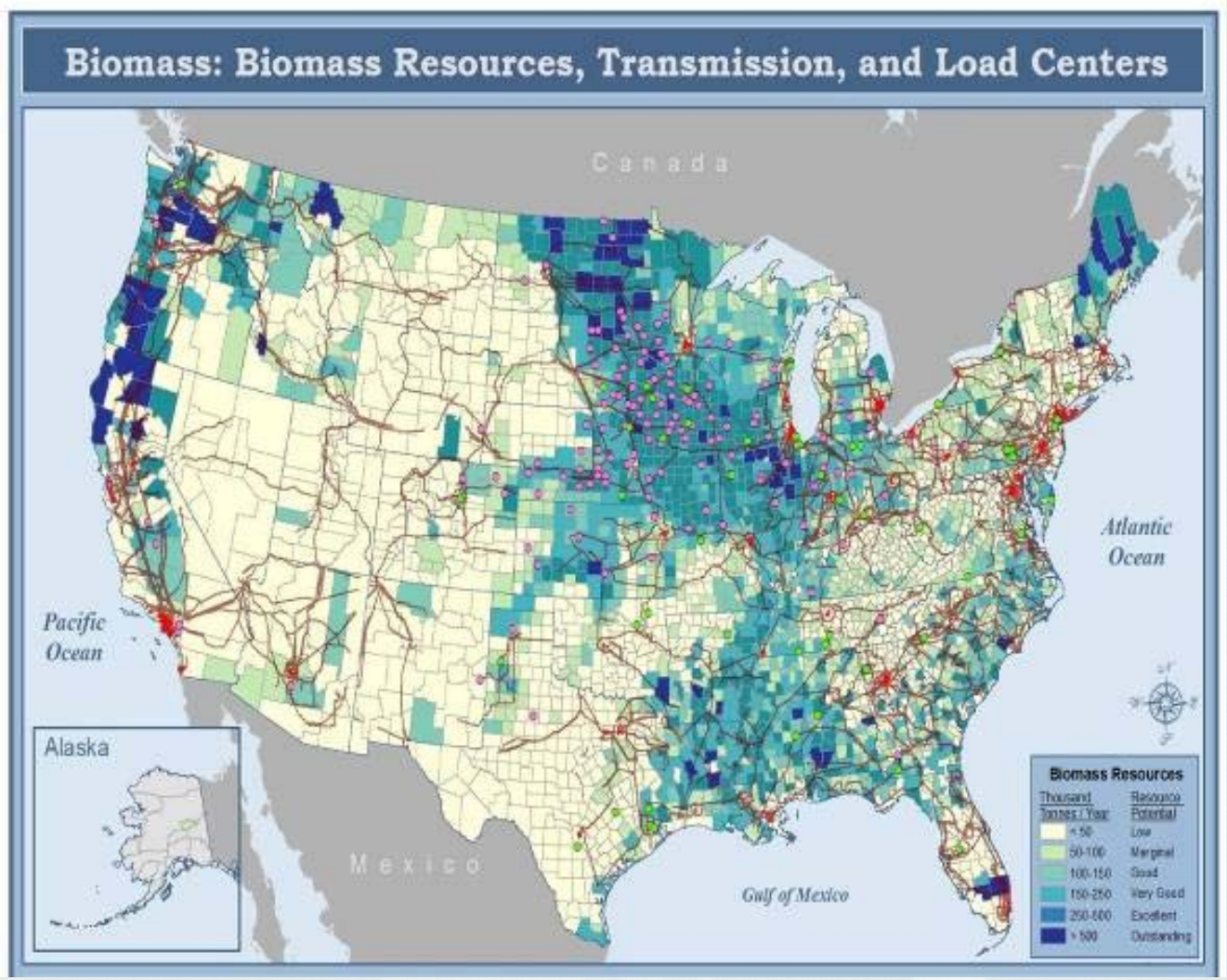
Potential Biomass Resource Areas

and Transmissions Centers and Paths



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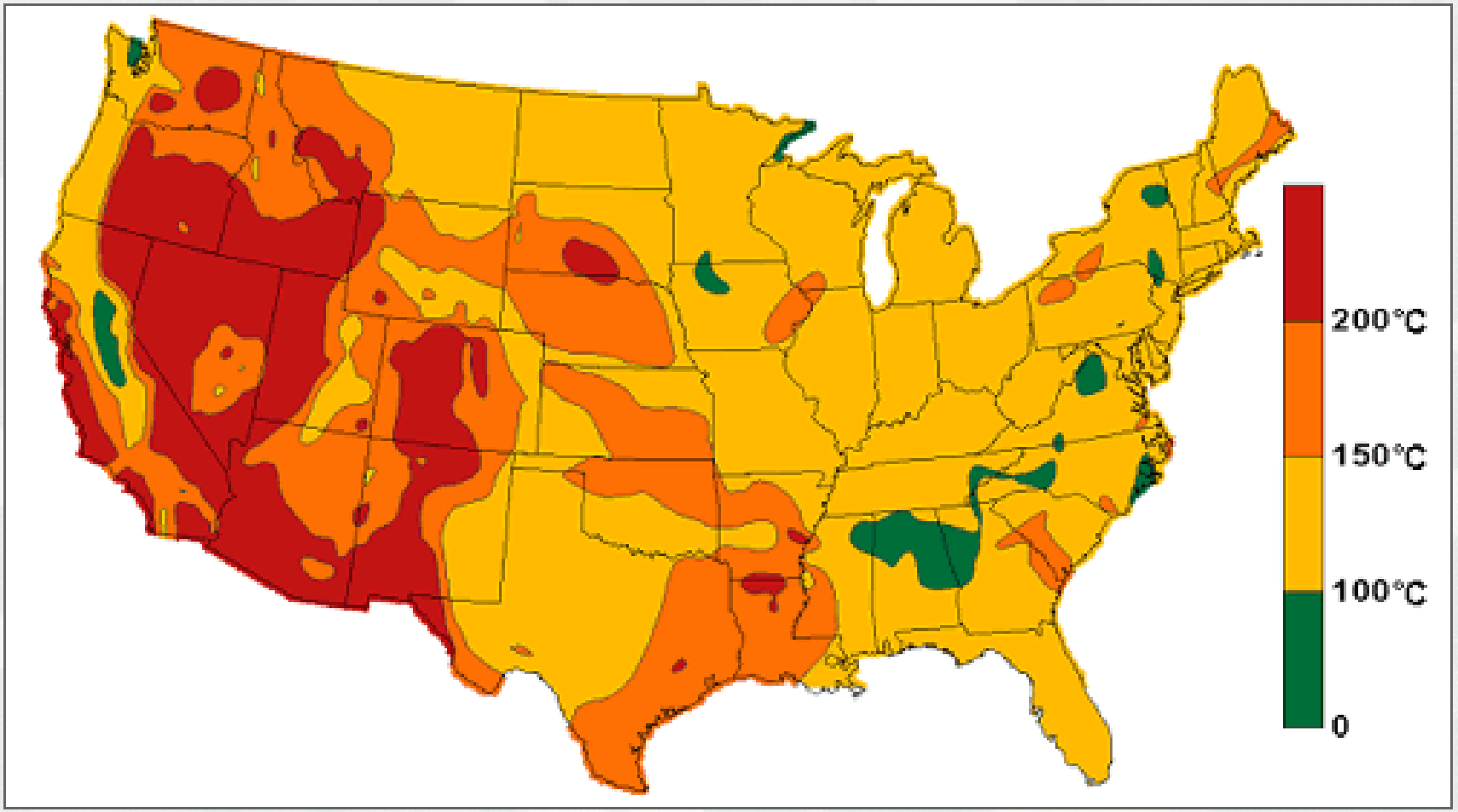
Generalized Geothermic Resource Potential



Solar Energy

Solar energy station at Air Force Base

SEGS at Daggett and
Kramer Junction, CA.

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Wind Energy

Air Force

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Biomass Conversion

Geothermal Energy

270-MW Geothermal Electric Power Plant, Navy

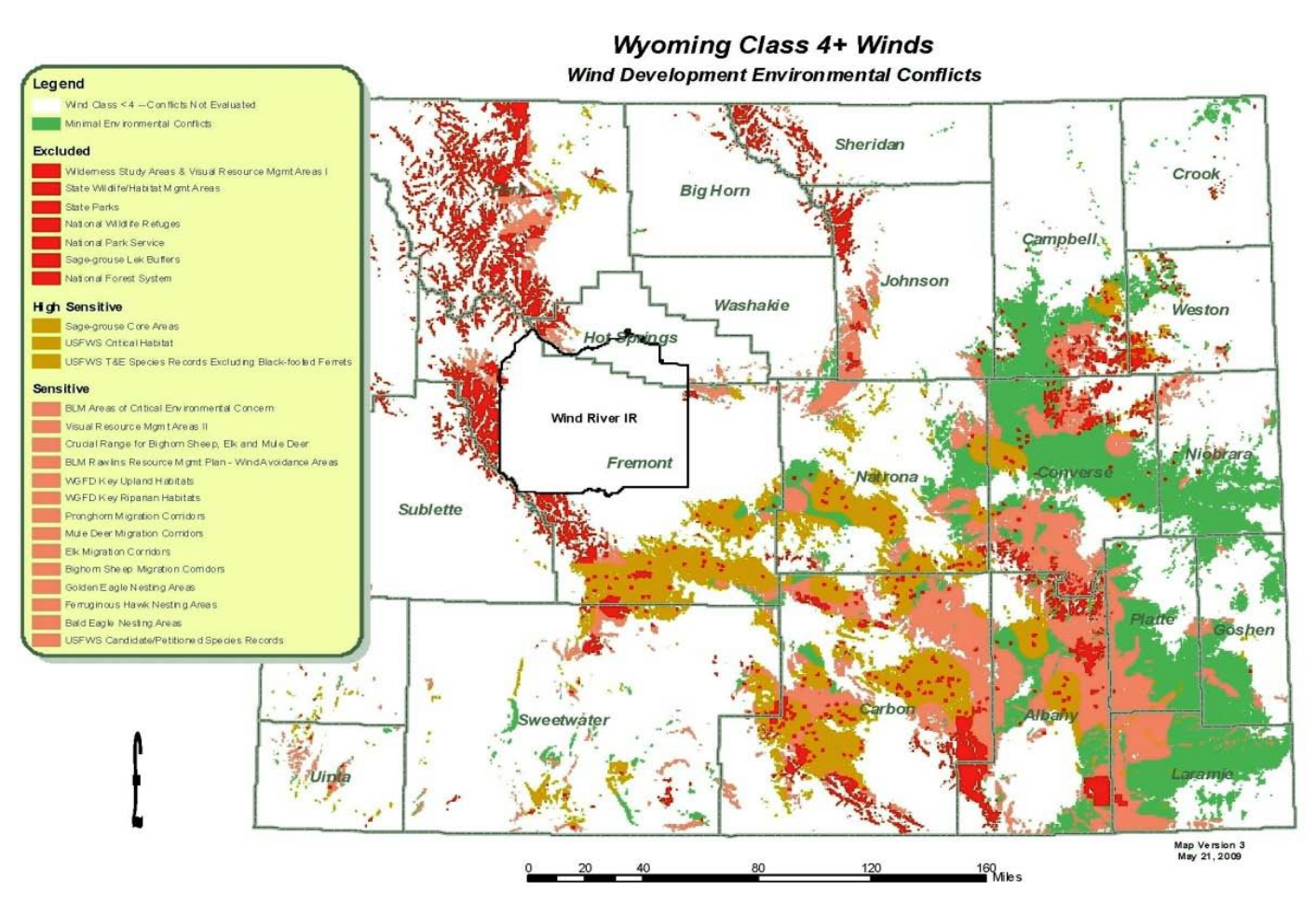
Environmental and Mission Considerations

The development and implementation of renewable energy opportunities, efforts, and projects can present significant challenges in ecosystem management and ecosystem tradeoffs. This is true whether the military services are a proponent, a user, or consumer (or some combination of these roles).

Environmental and Mission Considerations

- Geology, soils, seismic activity
  - Substrate, topography
  - Erosion – water, wind
  - Fault lines, earthquake zones
- Climate
  - Cloud cover
  - Sun, exposure
- Biology
  - Migration, movement
  - Mortality
  - Landscape ecology
  - Vegetative cover
  - Aquatic, marine

Example of Renewable Wind Energy Environmental Developmental Conflicts



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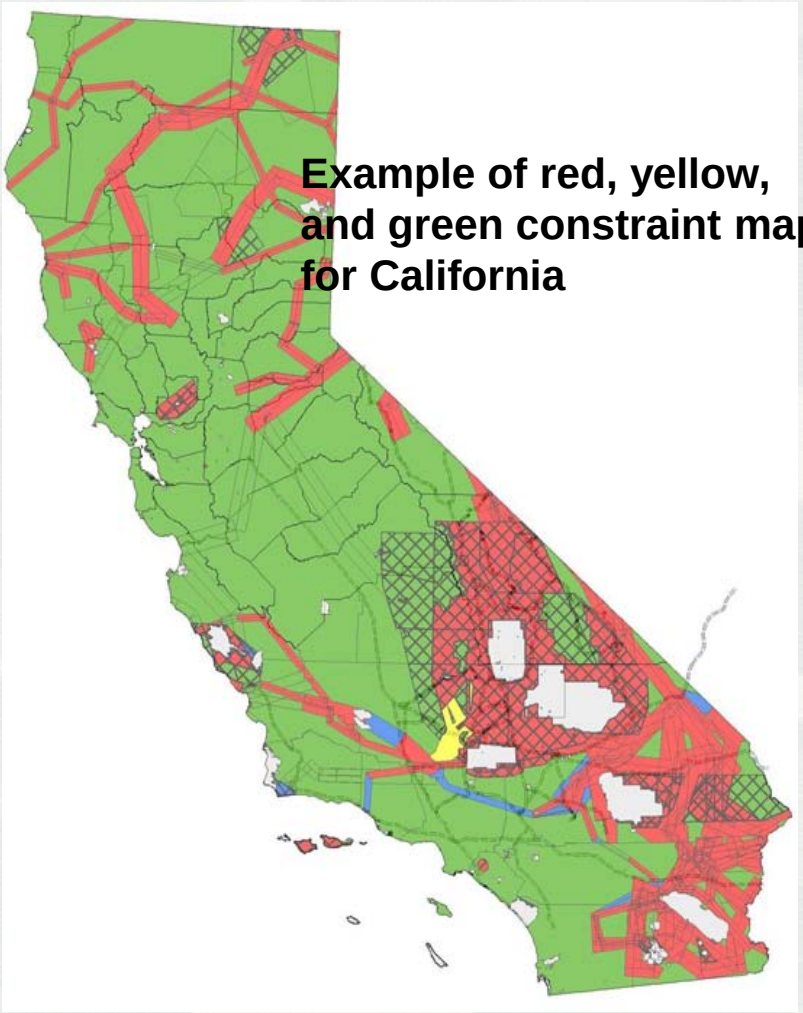
Environmental and Mission Considerations

- Water resources
  - Surface, ground
  - Quality, volume, seasonality
  - Demand, use, allocation, distribution, disposal
- Air quality
  - Greenhouse gases (carbon dioxide, carbon monoxide, methane, nitrous oxide)
  - Combustion (particulate matter, refrigerants (hydrofluerocarbons)
- Air space
  - Military, civilian aircraft flight routes
- Communications – including radar and sonar
  - Reflection of electromagnetic signals, Doppler clutter
  - Cell phone towers, wireless Internet sites, radio repeater stations

Environmental and Mission Considerations

- Noise
  - Noise Pollution and Abatement Act
  - Effects unknown
- Visual
  - Example, Nantucket Sound
- Land use and ownership
  - Public, private
-



Example of red, yellow, and green constraint map for California

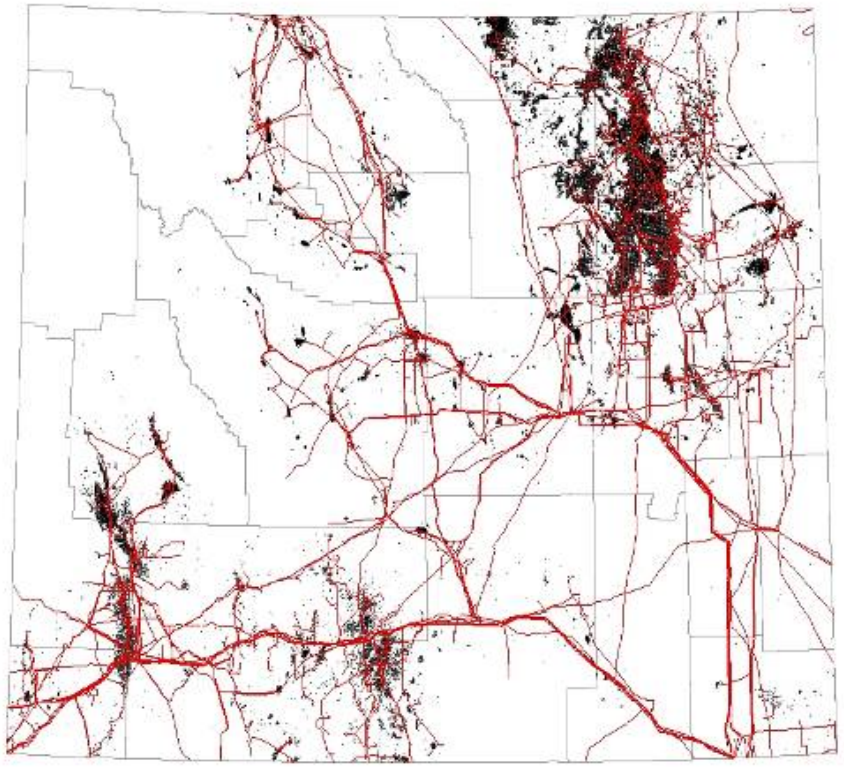
Private land renewable energy development

Environmental and Mission Considerations

- Urban growth
  - Confluence with military installations
  - Army Compatible Use Buffer Program (ACUB)
  - Land use change
- Socioeconomic factors
  - Job creation, job loss
  - Migration, movement of people
  - Increased demand for services (police, fire, recreation), housing, schools
  - Cropland, forestry conversion
- Transportation and utilities
  - Routes; habitat fragmentation, introduction of hazardous materials, required infrastructure
  - Private, public ownership

Environmental and Mission Considerations

Example of Transportation and Utilities Impacts



Oil and gas pipeline and well systems in Wyoming

Aerial view of the Jonah Field, WY showing local service roads and other infrastructure

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Environmental and Mission Considerations

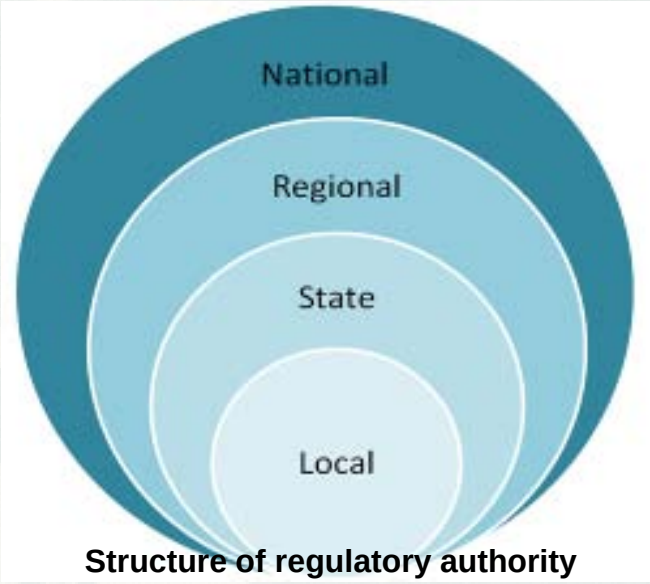
- Cultural resources
  - Tribal consultation, coordination
- Environmental justice
  - Minority, low income groups
  - Renewable energy development along borders
- Waste management and hazardous materials
  - Animal waste (methane generation); solar cells
  - Water and air quality
  - Hazardous gases and minerals (arsenic, mercury, ammonia)
- Recreation
  - Land use change; traditional uses
  - Traditional and historic use

Environmental and Mission Considerations

- Regulatory considerations/authority
  - Multiple permitting authorities
  - Differing permitting requirements/criteria

Summary of state delegation of zoning authority

Qualification	Number
States with zoning enabling laws	50
States with state-level zoning authority	2
States with county zoning authority	39
States with town/township zoning authority	13
States with municipal zoning authority	49
Estimated number of local zoning jurisdictions	20,000



Structure of regulatory authority

Environmental and Mission Considerations

- Cumulative effects
  - Human demographics
  - Different definitions – e.g., NEPA, ESA

Cumulative effects of wind energy development are easy to observe, but difficult to quantify

Large-scale Renewable Energy Technology vs. Ecosystem Considerations




	Geology, Soils, Seismic Activity	Climate	Biology	Water Resources	Air Quality	Air Space	Communications	Noise	Visual	Land Use and Land Ownership	Cultural Resources	Urban Growth	Socioeconomic Factors	Transportation and Utilities	Environmental Justice	Waste Management and Hazardous Materials	Recreation	Cumulative Effects	Regulatory Considerations/Authority
Solar – PV*		X	X		X				X	X	X	X	X	X	X	X	X	X	X
Solar – Concentrating PV		X	X	X	X				X	X	X	X	X	X	X	X	X	X	X
Solar – Concentrating Thermal Electric*		X	X	X	X				X	X	X	X	X	X	X	X	X	X	X
Wind	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Biomass (Energy Crops and Biofuels)	X	X	X	X						X	X	X	X	X	X	X	X	X	X
Biomass (Waste-to-Energy)			X	X						X	X	X	X	X	X	X	X	X	X
Geothermal	X			X	X				X	X	X	X	X	X	X	X	X	X	X

* There are three major concentrating solar thermal electric technologies that might be considered: (1) parabolic trough (upper left photo), (2) concentrating dish sterling, and (3) power tower.

Generalized Screening for Renewable Energy Projects

Potentially Affected Environmental Resource	Renewable Energy Source			
	Solar	Wind	Biofuel	Geothermal
Military land use	X	X	X	X
Geology, soils, seismic			X	X
Climate	X	X	X	
Biological resources	X	X	X	X
Water resources				X
Air quality			X	X
Air space		X		
Communications		X		
Noise		X		X
Visual	X	X		X
Land use, ownership	X	X	X	X
Cultural resources				
Urban growth	X	X	X	X
Socioeconomic factors	X	X	X	X
Transportation, utilities	X	X	X	X
Environmental justice	X	X	X	X
Waste, hazardous materials			X	X
Recreation	X	X	X	X

Where Do We Go From Here?

- Investigation and research be initiated to better inform decision-makers of the tradeoffs between renewable energy projects and the ecological, mission, and other unintended consequences of these projects.
- These tradeoffs are not well understood and should consider ecosystem services, GHG, energy production, and other criteria as tradeoff measures.
- In addition, long-term studies are needed to address many questions on impacts of renewable energy development or acquisition on ecosystem components, human health and mission capability.
- Some of the impacts may not be apparent in short term studies, and the types of impacts may differ over time as land use intensifies in regions where renewable infrastructure is sited, or where biomass is generated for biofuels.
- These studies are needed to inform and improve the plans and operations for long-term renewable energy projects, to help shape new projects, and to better understand and anticipate the cumulative impacts of multiple projects.
- Issues such as long-term ecosystem impacts, carbon balance from bio-resources, technology evolution, infrastructure degradation, etc. need to be addressed to minimize any negative effects resulting from renewable energy efforts.